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A DIFFERENCE IN THE METABOLISM OF THE SEXES

A DISSERTATION PRESENTED TO THE FACULTY OF ARTS, LITERATURE, AND SCIENCE, IN CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
(DEPARTMENT OF SOCIOLOGY AND ANTHROPOLOGY)

By WILLIAM I. THOMAS.

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It is increasingly apparent that all sociological manifestations proceed from physiological conditions. The variables entering into social consciousness and activity—technology, ceremonial, religion, jurisprudence, politics, the arts and professions, trade and commerce—have confessedly either a primary or a secondary connection with the struggle for food. Reproduction, a utilization of surplus nutrition, is also obviously in the closest possible relation with food, and the evidence here detailed is designed to show that the determination of sex is a chemical matter, maleness and femaleness being solely expressions of a difference of attitude toward food. If such a connection can be traced between sex and nutrition it will afford a starting point for a study of the comparative psychology of the two sexes and for the investigation of the social meaning of sex.

A grand difference between plant and animal life lies in the fact that the plant is concerned chiefly with storing energy, and the animal with consuming it. The plant by a very slow process converts lifeless into living matter, expending little energy and living at a profit. The animal is unable to change lifeless into living matter, but has developed organs of locomotion, ingestion, and digestion which enable it to prey upon the plant world and upon other animal forms, and in contrast with plant life it lives at a loss of energy. Expressed in biological formula, the habit of the plant is predominantly anabolic, that of the animal predominantly katabolic. Certain biologists, limiting their attention in the main to the lower forms of life, have maintained very plausibly that males are more katabolic than females, and that maleness is the product of influences tending to produce a katabolic habit of body.[1] If this assumption is correct, maleness and

[1] Geddes and Thomson, *The Evolution of Sex*, 1889, have presented this view in an

femaleness are merely a repetition of the contrast existing between the animal and the plant. The katabolic animal form, through its rapid destruction of energy, has been carried developmentally away from the anabolic plant form; and of the two sexes the male has been carried farther than the female from the plant process. The body of morphological, physiological, ethnological, and demographic data which follows becomes coherent, indeed, only on the assumption that woman stands nearer to the plant process than man, representing the constructive as opposed to the disruptive metabolic tendency.[1]

The researches of Düsing,[2] supplementing the antecedent observations of Ploss,[3] and further supplemented by the ethnological data collected by Westermarck,[4] may be regarded tentatively as having demonstrated a connection between an abundance of nutrition and females, and between scarcity and males, in relatively higher animal forms and in man. The main facts in support of the theory that such a connection exists are the following: Furriers testify that rich regions yield more furs from females and poor regions more from males. In high altitudes, where nutrition is scant, the birth rate of boys is high as compared with lower altitudes in the same locality. Ploss has pointed out, for instance, that in Saxony from 1847 to 1849 the yield of rye fell and the birth rate of boys rose with the approach

elaborate form. The present paper is an attempt to extend the general thesis to the human species, with a suggestion of its social implications.

[1] HAVELOCK ELLIS, *Man and Woman*, 1894, has brought together a mass of very valuable material on the question of the somatic and psychic differences of man and woman, but aside from some very sane remarks in their proper connection, has made no attempt to generalize his materials. H. CAMPBELL, in a volume of much the same scope, *Differences in the Nervous Organization of Man and Woman*, 1891, has given a résumé of the theory of Geddes and Thomson, and suggested its extension to the human species, but without attempting to work out the application in detail.

[2] C. DÜSING, *Die Regulirung des Geschlechtsverhältnisses bei der Vermehrung der Menschen, Thiere, und Pflanzen*, 1884; *Das Geschlechtsverhältniss der Geburten in Preussen*, 1890.

[3] H. PLOSS, "Ueber die das Geschlechtsverhältniss der Kinder Bedingenden Ursachen," *Monatsschrift für Geburtskunde und Frauenkrankheiten*, Vol. XII, pp. 321–60.

[4] E. WESTERMARCK, *The History of Human Marriage*, 1891, pp. 470–83.

of high altitudes. More boys are born in the country than in cities, because city diet is richer, especially in meat; Düsing shows that in Prussia the numerical excess of boys is greatest in the country districts, less in the villages, still less in the cities, and least in Berlin.[1] In times of war, famine, and migration more boys are born, and more are born also in poor than in well-to-do families. European statistics show that when food stuffs are high or scarce the number of marriages diminishes, and in consequence a diminished number of births follows, and a heightened per cent. of boys; with the recurrence of prosperity and an increased number of marriages and births, the per cent. of female births rises (though it never equals numerically that of the males).[2] More children are born from warm-weather than from cold-weather conceptions,[3] but relatively more boys are born from cold-weather conceptions. Professor Axel Key has shown from statistics of 18,000 Swedish school children that from the end of November and the beginning of December until the end of March or the middle of April, growth in children is feeble. From July-August to November-December their daily increase in weight is three times as great as during the winter months.[4] This is evidence in confirmation of a connection between maleness, slow growth, and either poor nutrition or cold weather, or both. Physical growth is also completed earlier by girls than by boys, and girls from the well-nourished classes reach puberty at an earlier age than girls from the poor classes. Professor Key's investigations[5] have also confirmed the well-known fact that maturity is reached earlier in girls than in boys, and have shown that in respect of growth the ill-nourished girls follow the law of growth of the boys. Growth is a function of nutrition, and puberty is a sign that somatic growth

[1] DÜSING, *Geburten in Preussen*, pp. 29–33.

[2] *Geburten in Preussen*, pp. 14–19.

[3] H. PLOSS, *Das Weib in der Natur- und Völkerkunde*, 3. Aufl., Vol. I, p. 419.

[4] AXEL KEY, "Die Pubertätsentwickelung und das Verhältniss derselben zu den Krankheitserscheinungen der Schuljugend," *Verhandlungen des X. Internationalen Medicinischen Congresses*, 1890, Vol. I, p. 91.

[5] *Ibid.*, pp. 84–90.

is so far finished that the organism produces a surplus of nutrition to be used in reproduction. Organically reproduction is also a function of nutrition, and, as Spencer pointed out, is to be regarded as discontinuous growth. The fact that an anabolic surplus, preparatory to the katabolic process of reproduction, is stored at an earlier period in the female than in the male, and that this period is retarded in the ill-nourished female, is a confirmation of the view that femaleness is an expression of the tendency to store nutriment, and explains also the infantile somatic characters of woman. Finally, the fact that polyandry is found almost exclusively in poor countries, coupled with the fact that ethnologists almost uniformly report a scarcity of women in those countries, permits us to attribute polyandry to a scarcity of women and scarcity of women to poor food conditions.

This evidence should be considered in connection with the experiments of Yung on tadpoles, of Siebold on wasps, and of Klebs on the modification of male and female organs in plants:

> According to Yung, tadpoles pass through an hermaphroditic stage, in common, according to other authorities, with most animals. . . . . When the tadpoles were left to themselves the females were rather in the majority. In three lots the proportion of females to males was, 54–46; 61–39; 56–44. The average number of females was thus about fifty-seven in the hundred. In the first brood, by feeding one set with beef Yung raised the percentage of females from 54 to 78; in the second, with fish, the percentage rose from 61 to 81; while in the third set, when the especially nutritious flesh of frogs was supplied, the percentage rose from 56 to 92. That is to say, in the last case the result of high feeding was that there were 92 females, and 8 males.[1]

> Similarly, the experiments of Siebold on wasps show "that the percentage of females increases from spring to August, and then diminishes. We may conclude without scruple that the production of females from fertilized ova increases with the temperature and food supply, and decreases as these diminish.[2]

> Nor are there many facts more significant than the simple and well-known one that within the first eight days of larval life the addition of food will determine the striking and functional differences between worker and queen.[3]

[1] GEDDES and THOMSON, *loc. cit.*, bk. i, chap. 4.

[2] ROLPH, quoted by GEDDES and THOMSON, *loc. cit.*, bk. i, chap. 4.

[3] GEDDES and THOMSON, *ibid.*

It is certainly no mere chance, but agrees with other well-known facts, that for the generation of the female organ more favorable external circumstances must prevail, while the male organ may develop under very much more unfavorable conditions.[1]

These facts are not conclusive, but they all point in the same direction, and are probably sufficient to establish a connection between food conditions and the determination of sex. But behind the mere fact that a different attitude toward food determines difference of sex, lies the more fundamental, indeed, the real explanation of the fact, and this chemists and physiologists are not at present able to give us. Researches must be carried further on the effect of temperature, light, and water on variation before we may hope to reach a positive conclusion. We can only assume that the chemical constitution of the organism at a given moment conditions the sex of the offspring, and is itself conditioned by various factors—light, heat, water, electricity, etc.—and that food is one of these variables.[2] It is sufficient for our present purpose that sex is a constitutional matter, indirectly dependent upon food conditions, that the female is the result of a surplus of nutrition, and that the relation reported among the lower forms persists in the human species.

In close connection with the foregoing we have the fact

[1] G. KLEBS, *Ueber das Verhältniss des männlichen und weiblichen Geschlechts in der Natur*, 1894, p. 19.

[2] Food affords the basis for metabolic changes in the parent organism, but it is probable that food is less *directly* related than heat and light to the determination of sex. Sachs, whose experiments must be given the greatest possible weight, has determined that the ultra-violet rays of light are necessary to the chemical changes essential to the formation of the reproductive organs. (J. SACHS, "Ueber die Wirkung der ultravioletten Strahlen auf die Blüthenbildung," *Gesammelte Abhandlungen über Pflanzen-Physiologie*, Vol. I, pp. 293 *seq.*) More recently, Klebs has shown that by diminishing the intensity of light the development of female sex organs in ferns can be interrupted, so that in spite of the presence of male organs fertilization is impossible; at the same time the prothallia are enabled in weak light to grow feebly and to put out small asexual processes, which in the presence of bright light become normal prothallia. Similarly, the development of sexual organs in *algæ* is dependent on a certain intensity of light, and the plant remains sterile if the light is diminished below a certain point. (G. KLEBS, *Ueber einige Probleme der Physiologie der Fortpflanzung*, 1895, pp. 13–16.)

reported by Maupas[1] that certain infusorians are capable of reproducing asexually for a number of generations, but that unless the individuals are sexually fertilized by crossing with unrelated forms of the same species they finally exhibit all the signs of senile degeneration, ending in death.[2] After sexual conjugation there was an access of vitality, and the asexual reproduction proceeded as before. "The evident result of these long and fatiguing experiments is that among the ciliates the life of the species is decomposed into evolutional cycles, each one having for its point of departure an individual regenerated and rejuvenated by sexual copulation."[3] The results obtained by Maupas receive striking confirmation in the universal experience of stock breeders that in order to keep a breed in health it is necessary to cross it occasionally with a distinct but allied variety. It appears, then, that a mixture of blood has a favorable effect on the metabolism of the organism, comparable to that of abundant nutrition, and that innutrition and in-and-in breeding are alike prejudicial. If this is true, and if heightened nutrition yields an increased proportion of females, we ought to find that breeding out is favorable to the production of females, and breeding in to the production of males; and a considerable body of evidence in favor of this assumption exists.[4]

[1] E. MAUPAS, "Théorie de la sexualité des Infusoires ciliés," *Comtes Rendus*, 1887, Vol. CV, pp. 356 *seq.*

[2] The extinction took place at about the 330th generation in *onychodromus grandis*, at about the 320th generation in *stylonichia mytilis*, at about the 330th generation in *leucophrys patula*, and at about the 660th generation in *oxytricha* (indeterminate). MAUPAS, *loc. cit.*, p. 358.

[3] MAUPAS, *loc. cit.*, p. 358.

The celebrated experiments of Maupas, taken in connection with recent investigations of Klebs, illustrate the fact that the phenomena characteristic of any given form can rarely be generalized. Klebs' experiments on *algæ* have shown that the same form can be rendered sexual or asexual at will. No sexual organs are produced in feeble light or in running water. The same form which reproduces sexually in stagnant water reproduces asexually and indefinitely in running water. (KLEBS, *loc. cit.*, p. 16.) It does not appear, however, that Maupas' conclusions are affected by this fact.

[4] WESTERMARCK, *loc. cit.*, pp. 476–83, following a suggestion of Düsing, has brought together much of the evidence on this point, but the application of the facts here made has not, I believe, been suggested.

Observations of above 4000 cases show that among horses the more the parent animals differ in color the more the female foals outnumber the male. Similarly, in-and-in bred cattle give an excessively large number of bull calves. Liaisons produce an abnormally large proportion of females,[1] incestuous unions, of males.[2] Among the Jews, who frequently marry cousins, the per cent. of male births is very high.

> According to Mr. Jacobs' comprehensive manuscript collection of Jewish statistics . . . . the average proportion of male and female Jewish births registered in various countries is 114.5 males to 100 females, whilst the average proportion among the non-Jewish population of the corresponding countries is 105.25 males to 100 females. . . . . His collection includes details of 118 mixed marriages; of these 28 are sterile, and in the remainder there are 145 female children and 122 male—that is, 118.82 females to 100 males.[3]

The testimony is also tolerably full that among *metis* and among exogamous peoples the female birth rate is often excessively high.[4]

Viewed with reference to activity the animal is an advance on the plant, from which it departs by morphological and physiological variations suited to a more energized form of life; and the female may be regarded as the animal norm from which the male departs by further morphological and physiological variations. It is now well known that variations are more frequent and marked in males than in females. Among the lower forms, in which activity is more directly determined mechanically by the stimuli of heat, light, and chemical attraction, and where in general the food and light are evenly distributed through the medium in which life exists, and where the limits of variation are consequently small, the constitutional nutritive tendency of the female manifests itself in size. Among many *cephalopoda* and *cirripedia*, and among certain of the *articulata* the female is larger than the male. Female spiders, bees, wasps, hornets, and butterflies are larger than the males, and the difference is noticeable

[1] A. VON OETTINGEN, *Die Moralstatistik*, 3. Aufl., p. 56.

[2] DÜSING, *Die Regulirung des Geschlechtsverhältnisses*, p. 237.

[3] WESTERMARCK, *loc. cit.*, pp. 479 and 481 n.

[4] *Cf.* WESTERMARCK, *ibid.*, pp. 476–83.

even in the larval stage. So considerable is the difference in size between the male and female cocoons of the silk-moth that in France they are separated by a particular mode of weighing.[1] The same superiority of the female is found among fishes and reptiles, and this relation wherever it occurs may be associated with a habit of life in which food conditions are simple and stimuli mandatory. As we rise in the scale toward backboned and warm-blooded animals the males become larger in size, and this reversal of relation, like the development of offensive and defensive weapons, is due to the superior variational tendency of the male resulting in characters which persist in the species wherever they prove of life-saving advantage.[2]

The superior activity and variability of the male among lower forms has been pointed out in great detail by Darwin and confirmed by others.

> Throughout the animal kingdom, when the sexes differ in external appearance, it is, with rare exceptions, the male which has been more modified; for, generally, the female retains a closer resemblance to the young of her own species, and to other adult members of the same group. The cause of this seems to lie in the males of almost all animals having stronger passions than the females.[3]

Darwin explains the greater variability of the males as shown in more brilliant colors, ornamental feathers, scent-pouches, the power of music, spurs, larger canines and claws, horns, antlers, tusks, dewlaps, manes, crests, beards, etc., as due to the operation of sexual selection, meaning by this "the advantage which certain individuals have over others of the same sex and species solely in respect of reproduction"[4] the female choosing to pair with the more attractive male, or the stronger male prevailing in a contest for the female. Wallace[5]

[1] G. DELAUNAY, "De l'égalité et inégalité des deux sexes," *La Revue scientifique*, 3 Sept., 1881; C. DARWIN, *Descent of Man*, chap. 10.

[2] A. WEISMANN, *Essays upon Heredity*, Vol. I, "The Duration of Life," has shown that size and longevity are determined by natural selection.

[3] C. DARWIN, *Descent of Man*, chap. 8.

[4] DARWIN, *ibid.*, chap. 8.

[5] A. R. WALLACE, *Contributions to the Theory of Natural Selection*, 1870, chap. 3

advanced the opposite view, that the female owes her soberness to the fact that only inconspicuous females have in the struggle for existence escaped destruction during the breeding season. There are fatal objections to both these theories; and, taking his cue from Tylor,[1] Wallace himself, in a later work, suggested the true explanation, namely, that the superior variability of the male is constitutional, and due to general laws of growth and development. "If ornament," he says, "is the natural product and direct outcome of superabundant health and vigor, then no other mode of selection is needed to account for the presence of such ornament."[2] That a tendency to spend energy more rapidly should result in more striking morphological variation is to be expected; or, put otherwise, the fact of a greater variational tendency in the male is the outcome of a constitutional inclination to destructive metabolism. It is a general law in the courtship of the sexes that the male seeks the female. The secondary sexual characters of the male are developed with puberty and in some cases these sexual distinctions come and go with the breeding season. What we know as physiological energy is the result of the dissociation of atoms in the organism; expressions of energy are the accompaniment of the katabolic or breaking-up process, and the brighter color of the male, especially at the breeding season, results from the fact that the waste products of the katabolism are deposited as pigments.

When we compare the sexes of mankind morphologically

[1] "If we take the highly decorated species; that is, animals marked by alternate dark or light bands or spots, such as the zebra, some deer, or the carnivora, we find, first, that the region of the spinal column is marked by a dark stripe; secondly, that the regions of the appendages, or limbs, are differently marked; thirdly, that the flanks are striped or spotted along or between the regions of the lines of the ribs; fourthly, that the shoulder and hip regions are marked by curved lines; fifthly, that the pattern changes, and the direction of the lines or spots, at the head, neck, and every joint of the limbs; and lastly that the tips of the ears, nose, tail, and the feet and the eye are emphasized in color. In spotted animals the greatest length of the spot is generally in the direction of the largest development of the skeleton."—A. TYLOR, *Coloration in Animals and Plants*, 1886, p. 92.

[2] A. R. WALLACE, *Darwinism*, chap. 10.

we find a greater tendency to variation in man and a greater tendency to atavism in woman.

All the secondary sexual characters of man are highly variable, even within the limits of the same race; and they differ much in the several races. . . . . Numerous measurements carefully made of the stature, the circumference of the neck and chest, the length of the backbone and of the arms, in various races . . . . nearly all show that the males differ much more from one another than do the females. This fact indicates that, as far as these characters are concerned, it is the male which has been chiefly modified, since the several races diverged from their common stock.[1]

Morphologically the development of man is more accentuated in almost every respect than that of woman. Anthropologists, indeed, regard woman as intermediate in development between the child and the man.

The outlines of the adult female cranium are intermediate between those of the child and the adult man; they are softer, more graceful and delicate, and the apophyses and ridges for the attachment of muscles are less pronounced, ... the forehead is . . . . more perpendicular, to such a degree that in a group of skulls those of the two sexes have been mistaken for different types; the superciliary ridges and the gabella are far less developed, often not at all; the crown is higher and more horizontal; the brain weight and cranial capacity are less; the mastoid apophyses, the inion, the styloid apophyses, and the condyles of the occipital are of less volume, the zygomatic and alveolar arches are more regular.[2]

Wagner decided that the brain of woman taken as a whole is uniformly in a more or less embryonic condition. Huschke says that woman is always a growing child and that her brain departs from the infantile type no more than the other portions of her body.[3] Weisbach[4] pointed out that the limits of variation in the skull of man are greater than in that of woman. Genius in general is correlated with an excessive development in brain growth, stopping dangerously near the line of hypertrophy and insanity, while microcephaly is a variation in the opposite direction in which idiocy results from arrested develop-

[1] DARWIN, *loc. cit.*, chap. 19.

[2] P. TOPINARD, *Éléments d'Anthropologie générale*, p. 253.

[3] DELAUNAY, *loc. cit.*

[4] WEISBACH, "Der deutsche Weiberschadel," *Archiv für Anthropologie*, Vol. III, p. 66.

ment of the brain through premature closing of the sutures; and both these variations occur more frequently in men than in women. The form of woman is rounder and less variable than that of man, and art has been able to produce a more nearly ideal figure of woman than of man; at the same time the bones of woman weigh less with reference to body weight than the bones of man, and both these facts indicate less variation and more constitutional passivity in woman. The trunk of woman is slightly longer than that of man,[1] and her abdomen is relatively more prominent, and is so represented in art. In these respects she resembles the child and the lower races, *i. e.*, the less developed forms.[2] Ranke states that the typical adult male form is characterized by a relatively shorter trunk, relatively longer arms, legs, hands, and feet, and relatively to the long upper arms and thighs by still longer forearms and lower legs, and relatively to the whole upper extremity by a still longer lower extremity; while the typical female form approaches the infantile condition in having a relatively longer trunk, shorter arms, legs, hands, and feet, relatively to short upper arms still shorter forearms, and relatively to short thighs still shorter lower legs, and relatively to the whole short upper extremity a still shorter lower extremity[3]—a very striking evidence of the ineptitude of woman for the expenditure of physiological energy through motor action. Morphological differences are less in low than in high races, and the less civilized the race the less is the physical difference of the sexes. In woman the reproductive function fixes the form with relative definiteness at an early period; but the further variation and fixation of physical traits in man is conditioned by a multifarious activity, and it results that in the higher races men are both more unlike one another than in the lower races, and at the same time more unlike than the women of their own race; and the less civilized

[1] TOPINARD, *loc. cit.*, p. 1066.

[2] Topinard's figures (*loc. cit.*, p. 1066) show, however, that the Esquimaux and the Tasmanians have a shorter trunk than the Europeans.

[3] J. RANKE, "Beiträge zur physischen Anthropologie der Bayern," *Beiträge zur Anthropologie und Urgeschichte Bayerns*, Vol. VIII, p. 65.

the race the less is the physical difference of the sexes. A similar relation holds between the higher and lower classes of the same society. The measurements of Broca and Topinard show that the difference in cranial capacity of the inhabitants of the epoch of polished stone is about 127^{cc}, of the modern French of the provinces about 150^{cc}, and of Parisians about 222^{cc}. Several observers have recorded the opinion that women of dolichocephalic races are more brachycephalic, and women of brachycephalic races more dolichocephalic than the men of the same races. If this is true it is a remarkable confirmation of the conservative tendency of woman. "I have thought for several years that woman was, in a general way, less dolichocephalic in dolichocephalic races, and less brachycephalic in brachycephalic races, and that she had a tendency to approach the typical median form of humanity."[1] The skin of woman is without exception of a lighter shade than that of man, even among the dark races. This cannot be due to less exposure, since the women and men are equally exposed among the uncivilized races, and it is due to the same causes as the more brilliant plumage of male birds. "In the human species," says Delaunay, "whether we consider stature, color of the hair, muscular strength, voice, tastes, ideas, or even chirography, we find among women a great resemblance and among men an immense difference."[2]

After making all deductions for the limitations of woman's activity by civilization (and they are many) we may still say that the cause of the greater variation of the male in mankind, as in the subhuman species, is the tendency to a rapid destruction of energy.[3]

[1] TOPINARD, *loc. cit.*, p. 375.

[2] DELAUNAY, *loc. cit.*

[3] If the common characters of a genus are more evident in the female than the male we may look also in the female for the persistence of characters which in the course of organic evolution are vanishing, and Paul Albrecht, in a somewhat brutal paper on the greater bestiality of woman, from the anatomical standpoint, has maintained that she stands nearer than man to our prehistoric ancestors in the following respects: In woman the stature is less than that of man; both dolichocephaly and prognathism are more marked and of more frequent occurrence; the inner incisors are more power-

We have no other than a utilitarian basis for judging some variations advantageous and others disadvantageous. We can estimate them only with reference to activity and the service or disservice to the individual and society implied in them, and a given variation must receive very different valuations at different historical periods in the development of the race. Departures from the normal are simply nature's way of "trying conclusions." The variations which have proved of life-saving advantage have in the course of time become typical, while the individuals in which unfavorable variations, or defects, have occurred have not survived in the struggle for existence. Morphologically men are the more unstable element of society, and this instability expresses itself, as we have seen, in the two extremes of genius and idiocy; and we have conclusive evidence that defects in general are more frequent in men than in women.

A committee reported to the British Association for the Advancement of Science, in 1894,[1] that of some 50,000 children (26,287 boys, and 23,713 girls) seen personally by Dr. Francis Warner (1892–1894) 8941 were found defective in some respect. Of these 19 per cent. (5112) were boys, and 16 per cent. (3829) were girls.

An examination of 1345 idiots and imbeciles in Scotland by Mitchell showed the following distribution of the sexes:

	Male	Female		Male		Female
Idiots, - - -	430	284	or	100	to	66.0
Imbeciles, - -	321	310	or	100	to	96.5

showing that "the excess of males is much greater among idiots

fully developed; the *trochanter tertius* occurs more frequently (more frequently, indeed, than in the apes); the anchylosis of the first coccyggeal vertebra with the sacrum is less frequent; the presence of a fifth coccyggeal vertebra is more frequent; hypertrichosis is more frequent, baldness less frequent; resort to biting and scratching is more frequent. (Ploss, *loc. cit.*, Vol. I, p. 5.) His argument, while obviously not free from whimsicality, confirms the view that woman is less anatomically developed than man.

[1] "Physical and Mental Deviations from the Normal among Children in Public Elementary and Other Schools," *Report of the Sixty-fourth Meeting of the British Association for the Advancement of Science, 1894*, p. 434 *seq.*

than among imbeciles; in other words, that the excess of males is most marked in the graver forms of the disease."[1]

A census of the insane in Prussia in 1880 showed that 9809 males, and 7827 females were born idiots. Koch's statistics of insanity show that in idiots there is almost always a majority of males, in the insane a majority of females. But the majority of male idiots is so much greater than the majority of female insane that when idiots and insane are classed together there remains a majority of males.[2] Insanity is, however, more frequently induced by external conditions, and less dependent on imperfect or arrested cerebral development. Mayr has shown from statistics of Bavaria that insanity is infrequent before the sixteenth year; and even before the twentieth year the number of insane is not considerable.[3] In insanity the chances of recovery of the female are greater than those of the male, and mortality is higher among insane men than among insane women. There is practical agreement among pathologists on this point.[4] Campbell points out in detail[5] that the male sex is more liable than the female to gross lesions of the nervous system, a fact which he attributes to the greater variability of the male.

An excess of all other anatomical anomalies, except cleft palate, is reported among males. Manley reports that of 33 cases of harelip treated by him only 6 were females.[6] It appears also that supernumerary digits are more frequent in males. Wilder[7] has recorded 152 cases of individuals with supernumerary digits, of whom 86 were males, 39 females, and 27 of unknown sex. A similar relation, according to Bruce, exists in regard to supernumerary nipples.[8] Muscular abnormalities,

[1] A. MITCHELL, "Some Statistics of Idiocy," *Edinburgh Medical Jour.*, Vol. XI, p. 639.

[2] "Koch's Statistics of Insanity," *Jour. of Ment. Sci.*, Vol. XXVI, p. 435.

[3] MAYR, *Die Verbreitung der Blindheit, der Taubstummheit, des Blödsinns und des Irrsinns in Baiern*, p. 100.

[4] See CAMPBELL, *loc. cit.*, p. 146 *seq.*

[5] CAMPBELL, *ibid.*, pp. 132–40.

[6] J. H. MANLEY, "Harelip," *International Med. Jour.*, Vol. II, p. 209 *seq.*

[7] *Communications of the Massachusetts Med. Soc.*, Vol. II, No. 3, p. 9.

[8] Of the 3956 individuals examined, 1645 were males, and of these 47 (2.857 per

monstrosities, deaf-mutism, clubfoot, and transposition of viscera are also reported as of commoner occurrence in men than in women.[1] Lombroso states that congenital criminals are more frequently male than female.[2] Cunningham noted an eighth (true) rib in 14 of 70 subjects examined. It occurred 7 times in males and 7 times in females, but the number of females examined was twice as large as the number of males.[3] The reports of the registrar-general show that for the years 1884–1888 inclusive the deaths from congenital defects (spina bifida, imperforate anus, cleft palate, harelip, etc.) were, taking the average of the five years, 49.6 per million of the persons living in England for the male sex, and 44.2 for the female.[4]

It has already been noted as a general rule throughout nature that the male seeks the female, and physicians generally believe that men are sexually more active than women,[5] though woman's need of reproduction is greater,[6] and celibacy unquestionably impresses the character of woman more deeply than that of man. Additional evidence of the greater sexual activity of man is furnished by the overwhelmingly large proportion of

cent.) presented supernumerary nipples. Of the 3956 individuals 2311 were females, and of these 14 (.605 per cent.) presented supernumerary mammæ or nipples. That is, this anomaly was found to occur more than four times as frequently in men as in women. J. MITCHELL BRUCE, "On Supernumerary Nipples and Mammæ," *Jour. of Anat. and Phys.*, Vol. XIII, p. 432.

Leichtenstern, however, whose investigations were of earlier date than those of Bruce, says that supernumerary mammæ occur with about equal frequency in the two sexes. LEICHTENSTERN, "Ueber das Vorkommen und die Bedeutung Supernumerärer Brüste und Brustwarzen," VIRCHOW'S *Archiv f. Patholog. Anat.*, Vol. LXXIII, p. 238.

[1] ELLIS, *loc. cit.*, pp. 358–65.

[2] LOMBROSO e FERRERO, *La Donna delinquente*, chap. 12.

[3] Hyrtl, of Vienna, however, examined thirty subjects, and found the anomaly in question only three times, and exclusively in females. He attributed it to tight lacing. D. J. CUNNINGHAM, "The Occasional Eighth True Rib in Man," *Jour. of Anat. and Physiol.*, Vol. XXIV, p. 127.

[4] H. CAMPBELL, *loc. cit.*, p. 133.

[5] KRAFFT-EBING, *Psychopathia Sexualis*, p. 14; CAMPBELL, *loc. cit.*, pp. 199–215; PLOSS, *loc. cit.*, Vol. I, p. 313.

[6] A. HEGAR, *Der Geschlechtstrieb*, p. 7.

the various forms of sexual perversion reported by psychiatrists in the male sex.[1]

Pathological variations do not become fixed in the species, because of their disadvantageous nature, but their excess in the male is, as we have seen in the case of variations which have become fixed, an expression of the more energetic somatic habit of the male.

A very noticeable expression of the anabolism of woman is her tendency to put on fat. "Women, as a class, show a greater tendency to put on fat than men, and the tendency is particularly well marked at puberty, when some girls become phenomenally stout."[2] The distinctive beauty of the female form is due to the storing of adipose tissue, and the form even of very slender women is gracefully rounded in comparison with that of man. Bischoff found the following relation between muscle and fat in a man of 33, a woman of 22, and a boy of 16, all of whom died accidentally and in good physical condition:[3]

	Man	Woman	Boy
Muscle, -	41.8	35.8	44.2
Fat, - -	18.2	28.2	13.9

The steatopyga of the women of some races and the accumulation of adipose tissue late in life are quasi-pathological expressions of this tendency.

The strength of woman, on the other hand, her capacity for motion, and her muscular mechanical aptitude are far inferior to that of man. Tests of strength made on 2300 students of Yale University[4] and on 1600 women of Oberlin College[5] show the mean relation of the strength of the sexes, expressed in kilograms:

	Back	Legs	R. forearm
Men, - -	153	186	56
Women, - -	54	76.5	21.4

[1] See, for example, MOLL, *Die Conträre Sexualempfindung;* KRAFFT-EBING, *loc. cit., passim.*

[2] H. CAMPBELL, *loc. cit.*, p. 115.

[3] Quoted by Ellis, *loc. cit.*, p. 41.

[4] DR. J. W. SEAVER, *Anthropometric Table*, 1889.

[5] DR. DELPHINE HANNA, *Anthropometric Table*, 1891.

The average weight of the men was 63.1 kilograms, and of the women 51 kilograms, and making deduction for this, the strength of the men is still not less than twice as great as that of the women. The anthropometric committee reported to the British Association in 1883 that women are little more than half as strong as men.

The first field day of the Vassar College Athletic Association was recently held (November 9, 1895), and a comparison of the records of some of the events with those of similar events at Yale University in the corresponding year, while by no means fair to the young women, gives us a basis of comparison:

	Yale	Vassar
100-yard dash, - -	10⅖ seconds	15¼ seconds
Running broad jump, -	23 feet	11.5 inches
Running high jump, -	5 ft. 9 in.	4 feet
220-yard dash, - -	22⅗ seconds	36¼ seconds

In tracing the transition from lower to higher forms of life we find a great change in the nature of the blood, or what answers to the blood, and the constitution of the blood is some index of the intensity of the metabolic processes going on within the organism. The sap of plants is thin and watery, corresponding with the preponderant anabolism of the plant. Blood is only "a peculiar kind of sap," and there is almost as much difference between this sap in warm-blooded and cold-blooded animals as between the latter and plants. Rich, red blood characterizes the forms of life fitted for activity and bursts of energy. In his exhaustive work on the blood Hayem has given a summary of the results of the investigations of chemists and physiologists on the differences in the composition of the blood in the two sexes. Contrary to the assertion of Robin, Hayem finds that the white blood corpuscles are not more numerous in women than in men, and he also states that the number of hæmatoblasts is the same in the two sexes. All chemists are agreed, however, that the number of red corpuscles is greater in men than in women. Nasse found in man 0.05824 of iron to 100, and in woman only 0.0499. Becquerel and Rodier give 0.0565 for

man, 0.0511 for woman, and Schmidt, Scherer, and others give similar results. Welcker (using a chronometer) found between the corpuscles of man and woman the relation of 5 to 4.7, and Hayem confirmed this by numeration. Cadet found in woman on the average 4.9 million corpuscles per the cmm., and in man 5.2 million. More recently Korniloff, using still another method — the spectroscope of Vierordt — has reached about the same result. The proportion of red blood corpuscles varies according to individual constitution, race, and sex. In robust men Lacanu found 136 red corpuscles in 1000, in weak men only 116 in 1000; in robust women only 126 in 1000, and in weak women 117.[1] Professor Jones has taken the specific gravity of the blood of above 1500 individuals of all ages and of both sexes.[2] An examination of his charts shows that the specific gravity of the male is higher than that of the female between the ages of 16 and 68. Between the ages of 16 and 45 the average specific gravity of the male is about 1058, and that of the female about 1054.5. At 45 years the specific gravity of the male begins to fall rapidly and that of the female to rise rapidly, and at 55 they are almost equal, but the male remains slightly higher until 68 years, when it falls below that of the female. The period of marked difference in the specific gravity of the blood is thus seen to be coincident with the period of menstruation in the female. A chart constructed by Leichtenstern, based upon observations on 191 individuals and showing variations in the amount of hæmoglobin with age, is also reproduced by Professor Jones, suggesting that the variations in specific gravity of the blood with age and sex are closely related to variations in the amount of hæmoglobin. Leichtenstern states that the excess in men of hæmoglobin is 7 per cent. until the tenth year, 8 per cent. between 11 and 50 years, and 5 per cent. after the fiftieth year.[3] Jones states further[4] that the specific gravity is higher

[1] J. HAYEM, *Du Sang et de ses alterations anatomiques*, pp. 184–5.

[2] E. LLOYD JONES, "Further Observations on the Specific Gravity of the Blood in Health and Disease," *Journal of Physiology*, Vol. XII, pp. 299 *seq.*

[3] O. LEICHTENSTERN, *Untersuchungen über den Haemoglobulingehalt des Blutes*, p. 38.

[4] Pp. 316 *seq.*

in persons of the upper classes and lower in the poorer classes. Observations of boys who were inmates of workhouses gave a mean specific gravity of 1052.8 and on schoolboys a mean of 1056, while among the undergraduate students of Cambridge University he found a mean of 1059.5. Several men of very high specific gravity in the last group had distinguished themselves in athletics. "Workhouse boys are in most cases of poor physique, and one can hardly find a better antithesis than the general type of physique common among the athletic members of such a university as Cambridge."[1] There is no more conclusive evidence of an organic difference between man and woman than these tests of the blood. They permit us to associate a high specific gravity, red corpuscles, plentiful hæmoglobin, and a katabolic constitution.

A comparison of the waste products of the body and of the quantity of materials consumed in the metabolic process indicates a relatively larger consumption of energy by man. It is stated that man produces more urine than woman in the following proportion: men 1000 to 2000 grams daily; women 1000 to 1400 grams. As age advances the amount diminishes absolutely and relatively in proportion to the diminution of the energy of the metabolic process. A table prepared from adults of both sexes, twenty-five years of age, of the average weight of sixty kilograms shows a larger proportion both of inorganic and organic substances in the urine of men.[2] Milne Edwards has found that the bones of the male are slightly richer in inorganic substances than those of the female.[3]

The lung capacity of women is less, and they consume less oxygen and produce less carbonic acid than men of equal weight, although the number of respirations is slightly higher than in man. On this account women suffer deprivation of air more easily than men. They are not so easily suffocated, and are reported to endure charcoal fumes better, and live in high altitudes where men cannot endure the deprivation of oxygen.[4] The number of

[1] JONES, *ibid.*, pp. 316 *seq.*

[2] E. BOURGOIN, art. "Urines," *Dict. encyc. des sciences médicales.*

[3] DELAUNAY, *loc. cit.*

[4] DELAUNAY, *loc. cit.*; PLOSS, *loc. cit.*, Vol. I, pp. 36–7; ELLIS, *loc. cit.*, pp. 202–4.

deaths from chloroform is reckoned as from two to four times as great in males as in females, and this although chloroform is used in childbirth. Children also bear chloroform well.[1] Women, like children, require more sleep normally than men, but "Macfarlane states that they can better bear the loss of sleep, and most physicians will agree with him. . . . . One of the greatest difficulties we have to contend with in nervous men is sleeplessness, a result, no doubt, of excessive katabolism."[2] Loss of sleep is a strain which, like gestation, women are able to meet because of their anabolic surplus. The fact that women undertake changes more reluctantly than men, but adjust themselves to changed fortunes more readily, is due to the same metabolic difference. Man has, in short, become somatically a more specialized animal than woman, and feels more keenly any disturbance of normal conditions, while he has not to meet the disturbance the same physiological surplus as woman.

Lower forms of life have the remarkable quality of restoring a lost organ, and of living as separate individuals if divided. This power gradually diminishes as we ascend the scale of life, and is lost by the higher forms. It is a remarkable fact, however, that the lower human races, the lower classes of society, women and children, show something of the same quality in their superior tolerance of surgical disease. The indifference of savage races to wounds and loss of blood has everywhere been remarked by ethnologists. Dr. Bartels has formulated the law of resistance to surgical and traumatic treatment in the following sentence: "The higher the race the less the tolerance, and the lower the culture-condition in a given race the greater the tolerance."[3] The greater disvulnerability of women is generally recognized by surgeons. The following figures from Lawrie, Malgaigne, and Fenwick are representative:[4]

[1] ELLIS, *loc. cit.*, p. 219.

[2] CAMPBELL, *loc. cit.*, pp. 117 and 119.

[3] MAX BARTELS, "Culturelle und Rassenunterschiede in Bezug auf die Wundkrankheiten," *Zeitschrift für Ethnologie*, Vol. XX, p. 183.

[4] LEGOUEST, art. "Amputations," *Dict encyc. des sciences médicales.*

LAWRIE (GLASGOW).

	Men		Women	
Pathological amputations, -	110 cases	29 deaths	41 cases	7 deaths
Traumatic "	106 "	59 "	14 "	4 "
Total, - - -	216	88	55	11
	or, 40.74 deaths per 100		20 deaths per 100	

A difference of 20.74 per cent. in favor of women.

MALGAIGNE (HOSPITALS OF PARIS).

	Men		Women	
Major pathological amputations,	280 cases	138 deaths	98 cases	44 deaths
Minor " "	106 "	9 "	40 "	2 "
Major traumatic "	165 "	107 "	17 "	10 "
Minor " "	73 "	13 "	10 "	0 "
Total - - -	624	267	165	56
	or, 37.98 deaths per 100		34.18 deaths per 100	

A difference of 3.8 per cent. in favor of women.

FENWICK (NEWCASTLE, GLASGOW, EDINBURGH).

	Men		Women	
Amputations, - -	304 cases	86 deaths	64 cases	16 deaths
	or, 27.86 deaths per 100		25 deaths per 100	

A difference of 2.86 per cent. in favor of women.

TOTAL FOR THE THREE SERIES.

	Men		Women	
Amputations, - -	1144 cases	441 deaths	284 cases	83 deaths
	or, 38.56 deaths per 100		29.29 deaths per 100	

A difference of 9.27 per cent. in favor of women.

Legouest states in the same article that the lowest mortality of all is in children from five to fifteen years of age. Ellis quotes a passage from a paper read by Lombroso at the International Congress of Experimental Psychology held in London :

Billroth experimented on women when attempting a certain operation (excision of the pylorus) for the first time, judging that they were less sensitive and therefore more *disvulnerable*, *i. e.*, better able to resist pain. Carle assured me that women would let themselves be operated upon almost as though their flesh were an alien thing. Giordano told me that even the pains of childbirth caused relatively little suffering to women, in spite of their apprehensions. Dr. Martini, one of the most distinguished dentists of

Turin, has informed me of the amazement he has felt at seeing women endure more easily and courageously than men every kind of dental operation. Mela, too, has found that men will, under such circumstances, faint oftener than women.[1]

The same tolerance of pain and misery in women is shown by an examination of the number of male and female suicides from physical suffering. Von Oettingen states that in 30,000 cases the per cent. of suicides from physical suffering was in men 11.4, in women 11.3,[2] and Lombroso, following Morselli, gives the following table representing the proportion out of a hundred suicides of each sex resulting from the same cause:[3]

	Men	Women
Germany (1852–1861)	9.61	8.08
Prussia (1869–1877)	6	7
Saxony (1875–1878),	4.61	6.21
Belgium,	1.34	0.84
France (1873–1878),	14.28	13.56
Italy (1866–1877),	6.70	8.50
Vienna (1851–1859),	9.20	10.04
" (1869–1878),	7.73	10.37
Paris (1851–1859),	10.27	11.22
Madrid (1884),	31.81	31.25

But these figures represent the number of suicides in each hundred of either sex, whereas suicide is three to four times as frequent among men as among women, and the absolute proportion of suicide among men from physical pain is, therefore, overwhelmingly great. Still more significant is a table given by Lombroso showing the per cent. of suicides from want.[3]

	Men	Women
Germany (1852–1861),	37.75	18.46
Saxony (1875–1878),	6.64	1.52
Belgium,	4.65	4.02
Italy (1866–1877),	7	4.60
" " (financial reverses),	12.80	2.20
Norway (1866–1870),	10.30	4.50
Vienna (1851–1859),	6.64	3.10

[1] ELLIS, *loc. cit.*, p. 123.

[2] A. VON OETTINGEN, *loc. cit.*, p. 780.

[3] LOMBROSO e FERRERO, *loc. cit.*, chap. 16.

But the excess of male suicides over female is so great that, reckoned absolutely, about one woman to seven or ten men is driven by want to take her life.

Physical suffering and want are among the motives which, constitutional differences aside, would appeal with about the same force to the two sexes. But the great excess both of suicide (3 or 4 men to 1 woman) and of crime (4 or 5 men to 1 woman), in men, while directly conditioned by a manner of life more subject to vicissitude and catastrophe, is still remotely due to the male, katabolic tendency which has historically eventuated in a life of this nature in the male.

Woman offers in general a greater resistance to disease than man. The following table from the registrar-general's report for 1888[1] gives the mortality in England per million inhabitants at all ages and for both sexes from 1854–1887 in a group of diseases chiefly affecting young children:

Disease	Year	Male	Female
Smallpox, - -	1854–1887	183	148
Measles, - -	1848–1887	426	408
Scarlet fever, - -	1859–1885	763	738
Diphtheria, -	1859–1887	157	176
Croup, - - -	1848–1887	221	192
Whooping cough,	1848–1887	451	554
Diarrhea, dysentery,	1848–1887	932	835
Enteric fever, -	1869–1887	288	277

or, a total mortality of 3421 per million for the males, and 3328 for the females. The greater fatality of diphtheria and whooping cough in the female is attributed to the smaller larynx of girls, and their habit of kissing. In diphtheria, indeed, the number of girls attacked is in excess of the boys, and it does not appear that their mortality is higher when this is considered.[2] Statistics based on nearly half a million deaths from scarlet fever in England and Wales (1859–1885) show a mean annual in males of 778, and in females of 717, per million living.[3] Dr

[1] P. xxi, Table F, quoted by Campbell, *loc. cit.*, p. 124.

[2] B. A. WHITELEGGE, "Milroy Lectures on Changes of Type in Epidemic Diseases," *Brit. Med. Jour.*, March 18, 1893.

[3] A. NEWSHOLME, *Vital Statistics*, 3d ed., p. 178.

Farr reports on the mortality from cholera in the epidemic years of 1849, 1854, 1866, that "the mean mortality from all causes in the three cholera years was, for males, 19.3 in excess, for females, 17.0 in excess of the average mortality to 10,000 living; so females suffered less than males. . . . . The mortality is higher in boys than in girls at all ages under 15; at the ages of reproduction, 25–45, the mortality of women, many of them pregnant, exceeds the mortality of men; but at the ages after 65 the mortality of men exceeds the mortality of women."[1] Statistics show that woman is more susceptible to many diseases, but in less danger than man when attacked, because of her anabolic surplus, and also that the greatest mortality in woman is during the period of reproduction, when the specific gravity of her blood is low and her anabolic surplus small. It is significant also that the point of highest mortality from disease and of the highest rate of suicide in the female, as compared with the male, falls at about 15 years, and is to be associated with the rapid physiological changes preceding that time.[2]

The numerical relation of the sexes at birth seems to be more variable in those regions where economic conditions and social usages are least settled, but in civilized countries the relation is fairly constant, and statistics of 32 countries and states between the years 1865 and 1883 show that to every 100 girls 105 boys are born, or including stillborn, 100 girls to 106.6 boys.[3] But the mortality of male children so much exceeds that of female that at the age of five the sexes are about in numerical equilibrium; and in the adult population of all European countries the average numerical relation of the sexes is reckoned as 102.1 women to 100 men. Von Oettingen gives a representative table[4] compiled from statistics of eight European countries, showing that (omitting the stillborn) 124.71 boys to 100 girls die before the end of the first year, and that between the years of 2 and 5 the proportion is 102.91 boys to 100 girls; or, about 25 per

[1] W. FARR, *Vital Statistics*, p. 385.

[2] Mortality from cancer is, however, much higher in women than in men. NEWSHOLME, *loc. cit.*, p. 208.

[3] PLOSS, *loc. cit.*, Vol. I, p. 26.

[4] VON OETTINGEN, *loc. cit.*, p. 58.

cent. excess of boys in the first year, and 3 per cent. in the years between 1 and 5. In the intra-uterine period and at the very threshold of life the mortality of males is still greater. The figures of Wappæus were 100 stillborn girls to 140.3 boys; Quetelt gave the proportion as 100 : 133.5; and the statistics of 14 European countries during the years 1865–1883 show that 130.2 boys were stillborn to every 100 girls.[1] So that while more boys than girls are born living, still more are born dead. That this astonishingly high mortality is due in part to the somewhat larger size of boys at birth and the narrowness of the maternal pelvis is indicated by the statement of Collins of the Rotunda Lying-in Hospital, Dublin, that within half an hour after birth only 1 female died to 16 males; within the first hour 2 females to 19 males, and within the first 6 hours 7 females to 29 males.[2] But that this explanation is not sufficient is shown by the fact that a high mortality of boys extends through the whole of the first year, and through five years, in a diminishing ratio, and also that the tenacity of woman on life, as will be shown immediately, is greater at every age than man's except during a period of about five years following puberty. "There must be," says Ploss, "some cause which operates more energetically in the removal of male than of female children just before and after birth,"[3] but besides the more violent movement of boys and their greater size no explanation of the cause has been advanced more acceptably than Haushofer's teleological one, quoted by Ploss, that nature wished to make a more perfect being of man, and therefore threw more obstacles in his way. A satisfactory explanation is found if we regard the young female as more anabolic, and more quiescent, with a stored surplus of nutriment by which in the helpless and critical period of change from intra- to extra-uterine conditions it is able to get its adjustment to life. The constructive phase of metabolism has prevailed in them even during fetal life. That there is need of a surplus of nutrition in the child at birth, or that a surplus

[1] Ploss, *loc. cit.*, Vol. I, p. 207.

[2] Ellis, *loc. cit.*, p. 377.

[3] Ploss, *loc. cit.*, Vol. I, p. 206.

will stand it in good stead, is indicated by the results of the weighing of children communicated by Winckel to the Gynæcological Society of Berlin in 1862. Winckel weighed 100 newborn children, 56 boys and 44 girls, showing that birth was uniformly followed by a loss of weight. The average diminution was about 108 grams the first day, and but little less the second day. At the end of five days the loss was 220 grams, six-sevenths of which occurred during the first two days.[1] The tendency to decreased vitality in girls after maturity and before marriage just referred to must be associated with the katabolic changes implied in menstruation and the newness to the system of this destructive phase of metabolism.

We should expect the death rate of men to run high during the period of manhood in consequence of their greater exposure to peril, hardship, and the storm and stress of life. But two tendencies operate to reduce the comparative mortality of men between the twentieth and about the fortieth year: the fact of the severe male mortality in infancy which has removed the constitutionally weak contingent, and the fact that during this period women are subject to death in connection with childbirth. So that in the prime of life the mortality of males does not markedly exceed that of females. But the statistics of longevity show that with the approach of old age the number of women of a given age surviving is in excess of the men, and that their relative tenacity of life increases with increasing years. Ornstein has shown, from the official statistics of Greece from 1878–1883, that in every period of five years between the ages of 85 and 110 years and upwards a larger number of women survive than of men, and in the following proportion:

Years	Men	Women
85– 90,	1296	1347
90– 95,	700	820
95–100,	305	370
100–105,	116	168
105–110,	52	69
110 and over,	20	34

[1] DEPAUL, art. "Nouveau-Né," *Dict. encyc. des sciences médicales.*

Of the 459 centenarians 188 were men and 271 were women.[1] In Bavaria the women aged from 51 to 55 years alive in 1874 had lived in the aggregate more then seven million years, while the men of the same age had lived not so much as six and one-half million.[2] Turquan[3] gives a table showing the death rate of centenarians in all France during a period of twenty years (1866–1885). From this it appears that there died in these years an annual average of 73 centenarians, of which 27 were men and 46 women. In only one year of the twenty did the deaths of men exceed those of women. Lombroso and Ferrero have shown that between 1870 and 1879 the inhabitants of the prisons and convict establishments in Italy who were over 60 years of age showed a percentage of 4.3 among the women, and 3.2 among the men, although the number of men condemned to prison for long periods is far greater than among women. "Women are not only longer lived than men, but have greater powers of resistance to misfortune and deep grief. This is a well-known law, which in the case of the female criminal seems almost exaggerated, so remarkable is her longevity and the toughness with which she endures the hardships, even the prolonged hardships, of prison life. . . . . I know some denizens of female prisons who have reached the age of 90, having lived within those walls since they were 29 without any grave injury to health."[4] Woman's resistance to death is thus more marked at the two extremes of life, infancy and old age, the periods in which her anabolism is uninterrupted. Menstruation, reproduction, and lactation are at once the cause of an anabolic surplus and the means of getting rid of it. At the extremes of life no demand of this kind is made on woman, and her anabolic nature expresses itself at these times in greater resistance.

Dr. Lloyd Jones has determined that between 17 and 45

[1] B. ORNSTEIN, "Makrobiotisches aus Griechenland," *Archiv für Anthropologie*, Bd. XVII, p. 193 *seq.*

[2] G. MAYR, *Die Gesetzmässigkeit im Gesellschaftsleben*, 1877, p. 144.

[3] V. TURQUAN, "Statistique des centenaires," in *Revue scientifique*, September 1, 1888.

[4] LOMBROSO e FERRERO, *loc. cit.*, chap. 10.

years of age the specific gravity of the blood of women is lower than that of men. In old women the specific gravity rises above that of old men, and he suggests that their greater longevity is due to this.[1] No doubt the greater longevity of women is to be associated with the rise in specific gravity of their blood, but this rise in the specific gravity of women after 45 years is consequent upon their anabolic constitution. High specific gravity in general is associated with abundant and rich nutrition; it falls in women during pregnancy, lactation, and menstruation, and when these functions cease it is natural that the constructive metabolic tendency on which they are dependent should show itself in a heightened specific gravity of the blood (*i. e.*, greater richness) and in consequence greater longevity.

Some facts in the brain development of women point to the same conclusion. The growth of the brain is relatively more rapid in women than in men before the twentieth year. Between 15 and 20 it has reached its maximum, and from that time there is a gradual decline in weight until about the fiftieth year, when there is an acceleration of growth, followed by a renewed diminution after the sixtieth year. The maximum of brain weight is almost reached by men at 20 years, but there is a slow increase until 30 or 35 years. There is then a diminution until the fiftieth year, followed by an acceleration, and at 60 years again a rapid diminution in weight, but the acceleration is more marked and the final diminution less marked in woman than in man.[2] The table on page 59, prepared by Topinard, shows that woman from 20 to 60 years of age has from 126 to 164 grams less brain weight than man, while her deficit from 60 to 90 years is from 123 to 158 grams.[3]

The only explanation at hand of this relative superiority of brain weight in old women is that with the close of the period of reproduction (the anabolic surplus being no longer consumed

[1] E. Lloyd Jones, "Further Observations on the Specific Gravity of the Blood in Health and Disease," *Journal of Physiology*, Vol. XII, p. 308.

[2] See Topinard, *Éléments d'Anthropologie générale*, 1885, pp. 517–25; 557–8.

[3] Topinard, *loc. cit.*, p. 559.

in the processes of menstruation, gestation, and lactation) the constructive tendency still asserts itself, and a slight access of growth and vitality results to the organism.

DIFFERENCE IN BRAIN WEIGHT FROM TWENTY TO SIXTY YEARS.

Author	Number of brains	Weight of women's brains gr.	Difference from man gr.
Broca (revised list of Wagner),	77	1,244	−126
Welcker,	258	1,247	−143
Peacock (Scotch),	89	1,275	−142
Boyd (English),	370	1,221	−133
Thurnam (various),	536	1,233	−138
Broca (registers),	51	1,195	−164
Bischoff,	272	1,227	−141
Broca–Bischoff–Boyd,	693	1,211	−150
FROM SIXTY TO NINETY YEARS.			
Broca (revised list of Wagner),	32	1,203	−123
Welcker,	99	1,175	−125
Boyd (English),	374	1,176	−124
Thurnam (various),	422	1,178	−131
Broca (registers),	85	1,111	−158
Bischoff,	50	1,157	−150

Organic development in general, and social structure and function in particular, are conditioned by this fundamental contrast in the metabolism of the sexes. Sex is, indeed, an expression of this difference, or, more exactly, it is this difference, and in the principle of sex lies the possibility of all higher development. Asexual organisms never rise above a low type of development because variation, on which development depends, is furnished only by the union of different organisms. The principle of sex is, therefore, to be recognized as the beginning of those changes which, controlled by natural selection, end in the development of organs of locomotion, prehension, ingestion, and digestion, fitting the organism increasingly for the struggle for food.

The struggle for food is, however, anti-social, or at best unsocial, in its beginning, and we must seek the principle of social

feeling in connection with reproduction. The transition from very low forms of life, controlled mechanically by the purely physical stimuli of heat, light, electricity, and acid,[1] to human society, characterized by an increasingly rational control of environment, is dependent on association. This principle of association has two aspects. In its connection with the food process its lowest expression is seen in the hostile coexistence of different species, affording an opportunity to the strong to prey upon the weak, and a higher expression is reached in human societies where division of labor makes a peaceful exchange of products possible. But the association connected with trade and commerce is never truly social; it is a civilized *bellum omnium inter omnes*.

Social feeling, as such, originates in the association connected with reproduction, and its physical basis is the anabolic nature of the female. Among the lower animal forms the conversion of the anabolic surplus of the female into offspring involves a great waste of physiological energy on the part of the female, but is followed by little or no association between parent and offspring. Since, in the absence of social feeling, the larger the number of offspring the larger the chance of survival of some, natural selection has in some cases enormously developed the capacity for physiological waste in the female; a thousand eggs may be spawned where only a single form comes to life or reaches maturity. But a higher type of development involves a closer association between the parent and offspring, and this is secured through natural selection by a modified structure in the female, culminating among the mammals in the intra-uterine development of the young and the disposition in the female to care for the young after bringing them forth. The expansion of the abdominal zone in the female in connection with this modification of her reproductive system is the physical basis of the altruistic sentiments. Feeling is a physiological change, and its seat is not the encephalon, but the viscera; the sense organs and the

[1] J. Loeb, *Der Heliotropismus der Thiere und seine Uebereinstimmung mit dem Heliotropismus der Pflanzen*, 1890.

encephalon simply mediate the perception which stimulates the vaso-motor system. The superior physiological irritability of woman, whether we call it sensibility, feeling, emotionality or affectability, is due to the fact of the larger development of her abdominal zone, and the activity of the physiological changes located there in connection with the process of reproduction.

This physiological predisposition of woman to feeling expresses itself primarily in love of offspring, and secondarily in ties of blood. Subsequent to the conversion of her surplus of energy into offspring there follows a period in which her surplus energy is converted into milk for the sustentation of the offspring, and the time during which the child draws its life from the breast of the mother is a moment of supreme importance for the development of the race, since it is in connection with this quasi-physiological association that the first altruistic sentiments are knit. The first social unit is not the family but the mother and her group of children, and the tribe is primarily an aggregation of those related by blood to a group of females.

Both social feeling and social organization are thus primarily feminine in origin — functions of the anabolism of woman. But natural selection operates still further in favoring both the offspring and the community where the male is associated in a supplementary way with the female in the expression of social feeling and the extension of social activities. Thus in the human species those races have prevailed in which in consequence of a monogamous system of marriage the providence of both parents is assured to the offspring, resulting in better nutrition and somatic and psychical training; and those nations have prevailed in which the katabolic energies of man have extended into a complicated political system based on territory, the tribal organization based on descent through females. But it is impossible that humanitarian sentiments should have been developed except as a supervention upon maternal affection, and impossible that political organization should have developed except as a supervention upon association based on ties of blood.

The history of art is also closely associated with the fact of sex. Woman has been historically the bearer of social sentiment, because of her capacity for feeling, and man has been the bearer of social will, because of his capacity for action. Art is a generalized expression of any affective phase of life. There are in art what we may call pure masculine motives, representing the disruptive, militant, katabolic nature of man: Prometheus and Hamlet and Laocoon in conflict with circumstance. Historical paintings and epic and dramatic poems frequently contain this motive. Again, such characters as Penelope, Antigone, Dorothea Brooke stand for what we may call the feminine motive in art, representing the capacity of the female for sacrifice. But the artistic situation *par excellence* is the softened representation of the biological fact that the katabolic male seeks the anabolic female — the affinity of Romeo and Juliet, of Caponsacchi and Pompilia.

The striking historical contrast and parallelism of the militant and industrial activities of society is a social expression of this sexual contrast. Man's katabolism predisposed him to activity and violence; woman's anabolism predisposed her to a stationary life. The first division of labor was, therefore, an expression of the characteristic contrast of the sexes. War and the chase were suitable to man, because his somatic development fitted him for bursts of energy, and agriculture and the primitive industries were the natural occupation of woman. This allotment of tasks was not made by the tyranny of man, but exists almost uniformly in primitive communities because it utilizes most advantageously the energies of both sexes. The struggle is so fierce and constant that the primitive community which should let any energy go to waste would not long survive. Through war and amalgamation the survival of the strongest ethnic type and the association of men in large numbers were secured, but this was only preliminary to the expansion (largely through the energies of man) of the industrial type of society represented from the beginning by the agriculture, arts, and manufactures of primitive woman. Devices for the artificial application of force were

largely developed in connection with the destructive activities of man, and the transfer of man's technological aptitude to the constructive side of life represented primarily by woman was the beginning of the indefinite extension of invention and the useful arts.[1]

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[1] A series of papers will follow this on the social psychology of sex, with especial reference to early association and social organization.